Laptop Fan System

Preface

As is the case with my laptop, after some time it gets slower and slower and the hardware starts to work worse. This is also the case with my laptop. I had a new Manjaro Linux/Cinnamon installation and still the laptop was running at +44C temperature. To take the air out of the sails of the critics. Yes, I have to change the fan again because it's broken and is mostly to blame for the high temperature. I still wanted to see if this would work if you screw a lot of fans under the laptop. There are laptop cooling pads that you can order in the internet, but they were all cheap plastic shit and I don't learn anything. Creative Creator inspired me a bit.

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☰
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Every 1.0s: sensors


Adapter:
temp1:            N/A  (crit = +120.0°C, hyst = +90.0°C)


Adapter:
temp1:          +40.0°C  (crit = +125.0°C)
temp2:          +0.0°C  (crit = +127.0°C)


Adapter:
 Package id 0:  +52.0°C  (high = +105.0°C, crit = +105.0°C)
 Core 0:        +52.0°C  (high = +105.0°C, crit = +105.0°C)
 Core 1:        +44.0°C  (high = +105.0°C, crit = +105.0°C)
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I noticed a lot about this project. The first was for example the realization that if you put your laptop off the table, the temperature will be reduced by -4C. You don't have to do anything. Just build a stand and save four degrees (or even more). Why is that so? With a laptop, the heat accumulates inside the case and in many cases is transported out of the case via an air vent. This ensures that the GPU/CPU remains at a moderate temperature and does not heat up. If these components overheat, they will damage and break. A large part of the heat accumulates in the case and is (very slowly) transported outside. If you put two materials next to each other, the heat is absorbed by one material. It's called *Heat Transfer between two Bodies*

> *If a hot body is brought in conducting contact with a cold body, the temperature of the hot body falls and that of the cold body rises, and it it is said that a quantity of heat has passed grom the hot to the cold body. (An Advanced Treatise On Physical Chemistry Vol I, Partington, J.R. (1949), p. 118. #).*

As the topic is very complex we will not go into it here, but I advise every reader to take a look at the topic in his spare time, as it is very exciting. Since we can't install fans inside the laptop, we have to cool the case down enough to cool the rest of the hardware. On the screenshot below we can see the result. All in all I was able to cool down the laptop -12C with my first test. That doesn't sound like much at first, but I just wanted to test if there is any cooling at all or if it's *internet technology voodoo*. In the conclusion, I will describe the result in more detail and set up further theories for the next version.

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Every 1.0s: sensors


Adapter:
temp1:            N/A  (crit = +120.0°C, hyst = +90.0°C)


Adapter:
temp1:          +32.0°C  (crit = +125.0°C)
temp2:          +0.0°C  (crit = +127.0°C)


Adapter:
 Package id 0:  +52.0°C  (high = +105.0°C, crit = +105.0°C)
 Core 0:        +52.0°C  (high = +105.0°C, crit = +105.0°C)
 Core 1:        +43.0°C  (high = +105.0°C, crit = +105.0°C)
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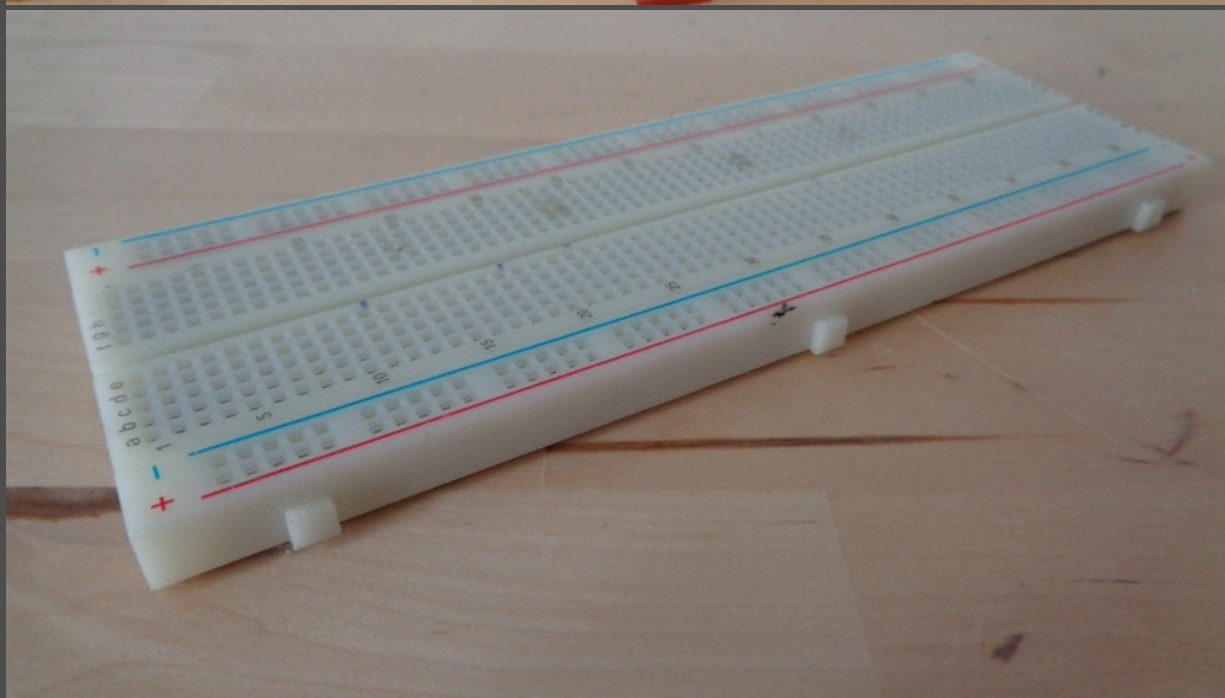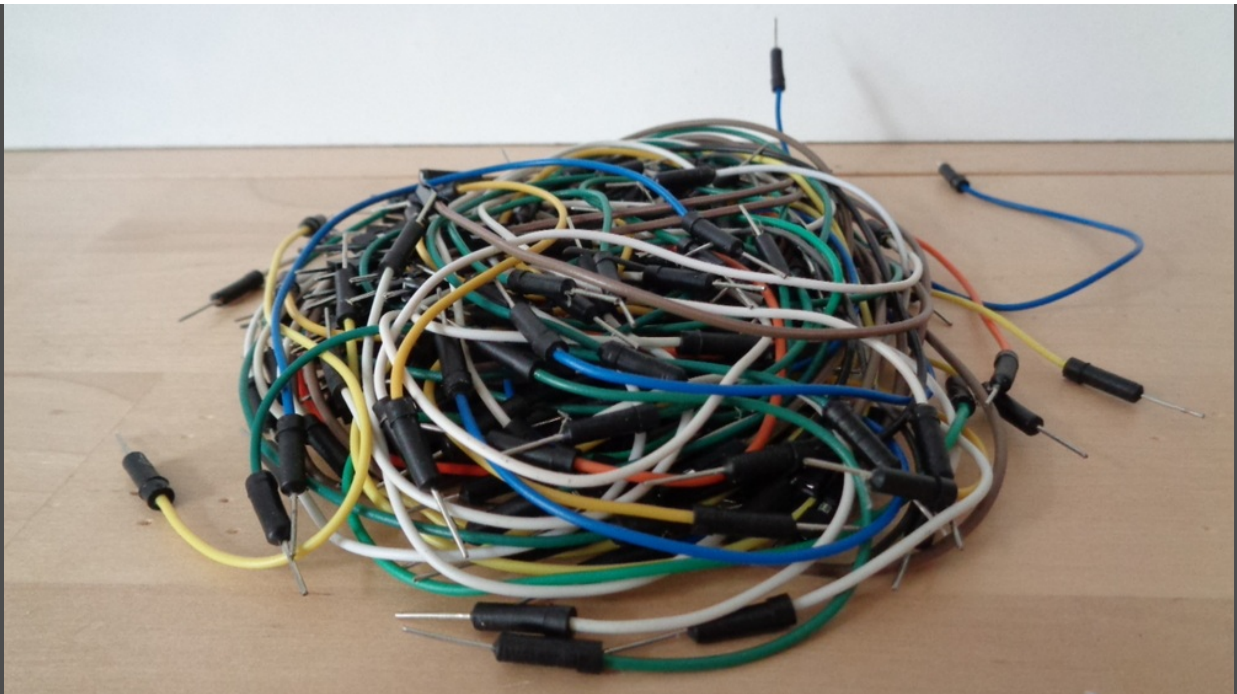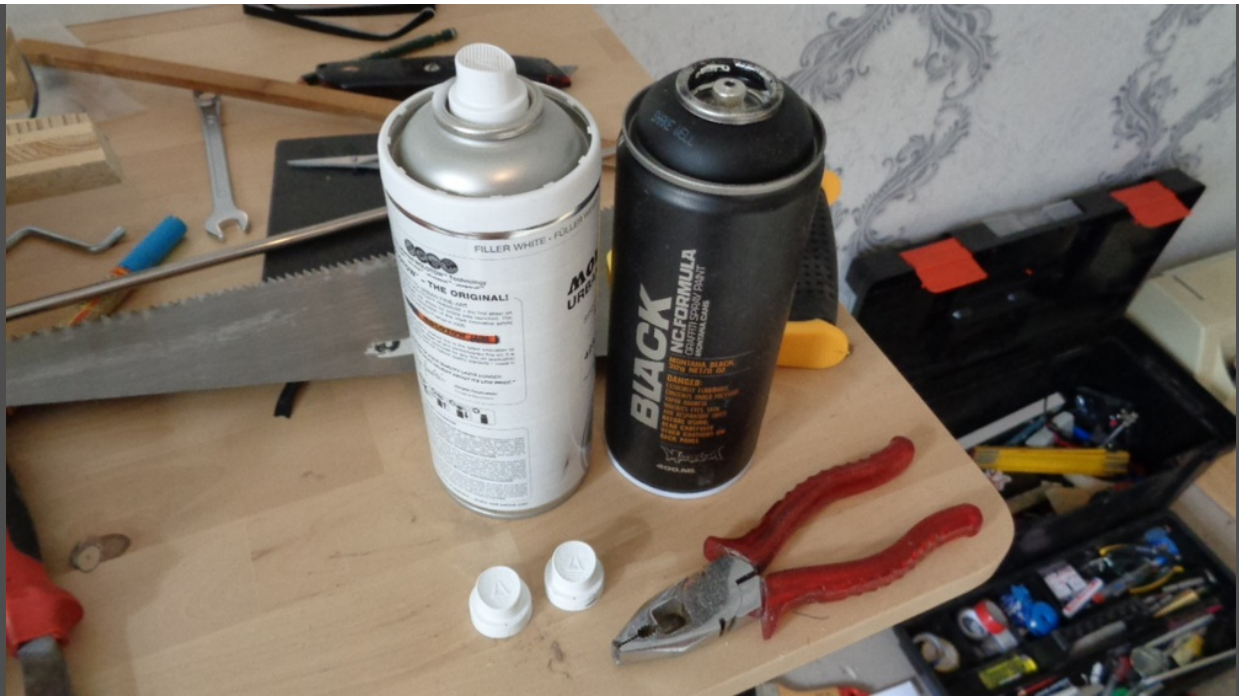
Material

In this tutorial we need a lot of materials. Some things you have to buy new, others you can get cheap at the flea market or on the internet. Since I collect a lot of old hardware and store it in cartons, I can always fall back on who I need for a project.

DC BRUSHLESS
MODEL AUB0712HH
DC12V 0.40A -T6L1
C9730R
DELTA ELECTRONICS, INC.
MADE IN THAILAND

BOSCH

- Table
- Laptop
- Brush
- Lots of (old/new)Fans (12V)
- Breadboard
- Breadboard Cable
- 6V Battery
- 6V Battery Connector
- On/Off Switch
- Lustre Clamp
- 12V Power Adapter
- Marker
- Sanding Block
- Sanding paper (60)
- Small Wood Sticks
- Small Wood Saw
- Hammer
- Screwdriver
- Metal Clamps
- Old Wood Plates
- Drill with Drill Heads
- Wood Glue
- Pipe Wrench
- Graphit Pen
- Small Metal Row
- Black Spray Paint
- Primer Spray
- Copper Tape
- Electrical Tape (Red/Black)
- Masking Tape
- Safety Glasses
- Heat/Shrink Tubing
- Solder and Solder Tin
- Scissors
- Hot Glue Gun

The Breadboard Prototype

I would like to make a brief comment on how we are going to proceed with this project. If you want to do the same is up to you and I don't make a law out of it. In the first step I clean the fans and test if all work, then I build a prototype on the breadboard. When the prototype is finished we will clean the table, sand it with sandpaper, drill the holes, repaint it etc. In the last step we will put the prototype under the desk. In between we will test our construction again and again.
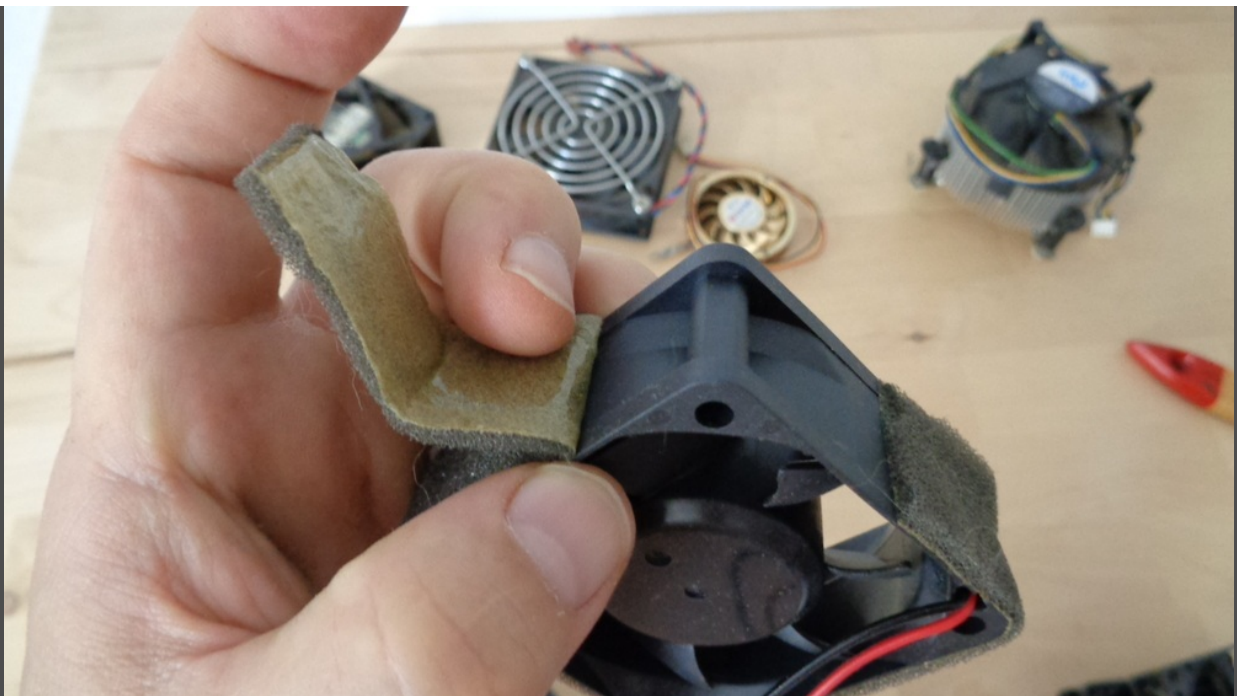
Since I didn't buy my fans new, but took them up from my cellar, I had to clean them first. A big brush helps. On some fans I had to take off all the tape or loosen a grid with a screwdriver. When cleaning, you should try hard, because that is the main reason why airplanes don't work so well anymore.
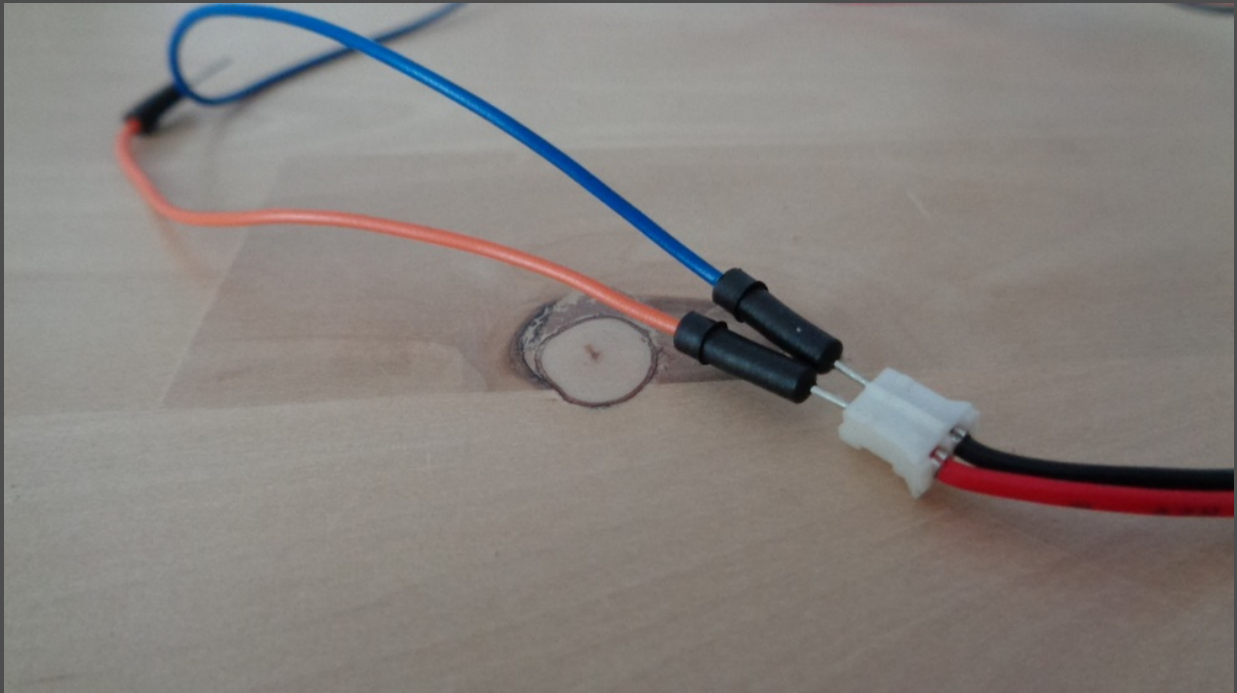

To test if the fans are working we will connect each one to a 6V battery. To do this we take two breadboard cables and plug them into the plugs of the fans. We then connect these cables to the battery. Don't be surprised if the (12V) fans run a little slower. This is due to the 6V battery. It arrives as only half of the energy to the fan.
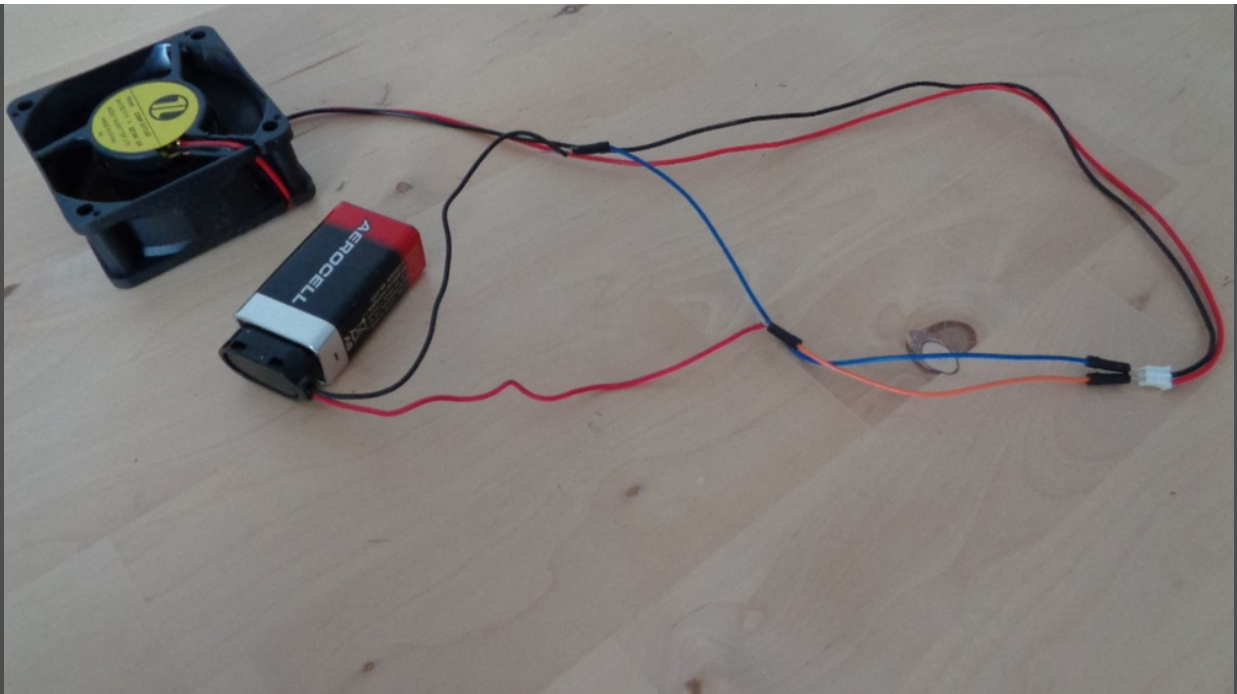
Here you can see the structure in detail. If you have swapped plus/minus the fan will not rotate. Either you have to change the cables (Plus/Minus - VCC/GND) once or the fan is broken. Maybe the battery is empty and you have to replace it. This can sometimes happen, if a battery is lying around for a long time and is not used, that it will discharge itself over years.
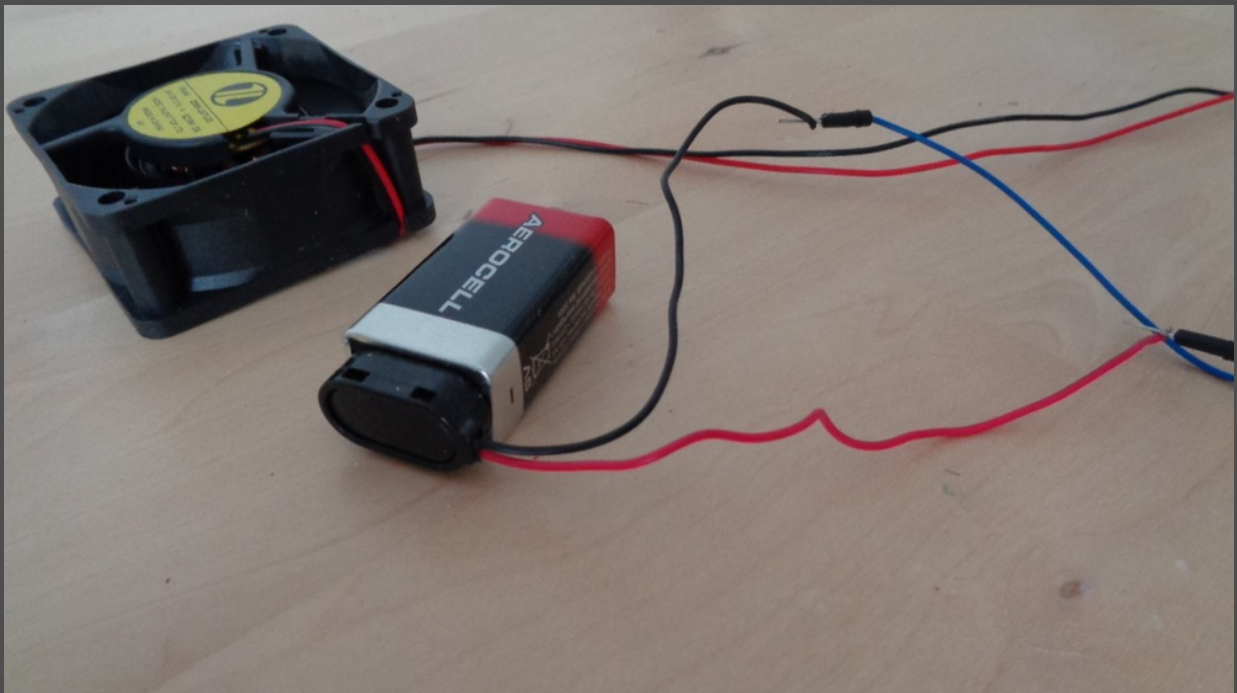

If the fan works you can plug the breadboard cables (which are connected to the fan) into the breadboard. As you can see on the photo, blue (GND) is minus and red (VCC) plus. On most breadboards this is arranged like this. If not, you can draw it with a waterproof red and blue pencil. If your project gets bigger, this will help you to keep the overview.
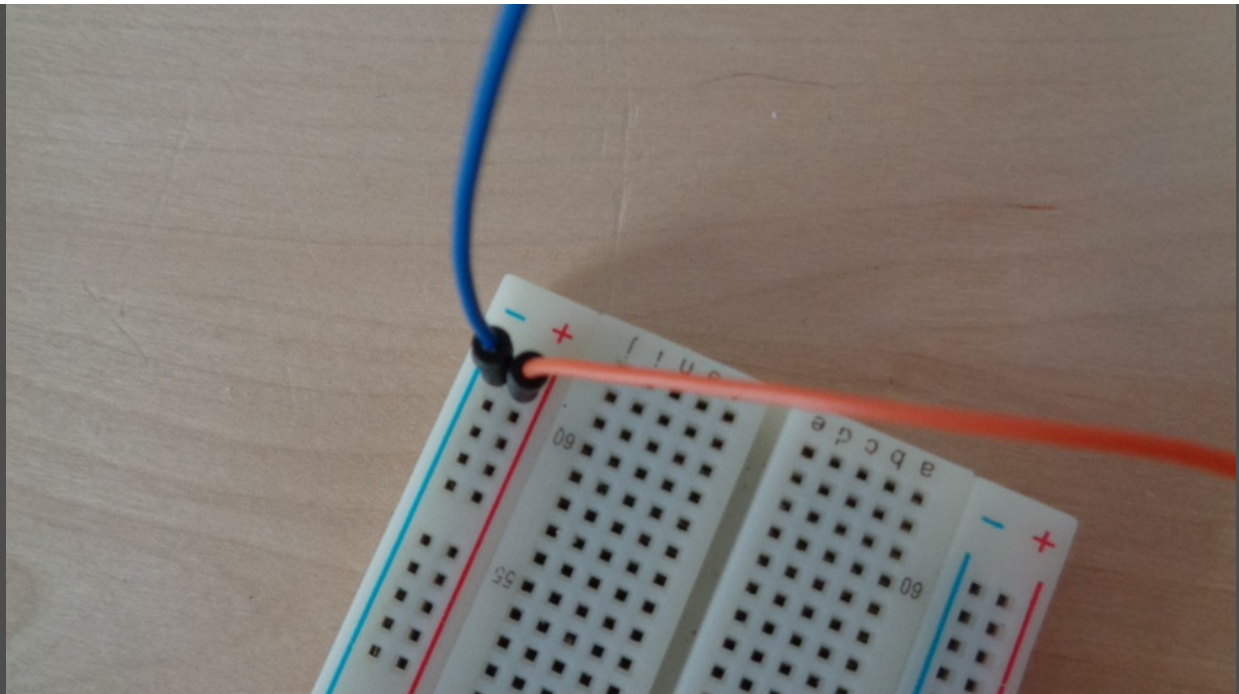
We'll do the process now as long as we've tested and connected all the fans. this can take a little time and you should take at least a whole day for the project. If you get a little confused with the colors of the cables you can remember that black is mostly (GND-) and red (Red+). Sometimes the cables of the fans can have different colors and then you just have to test what works.
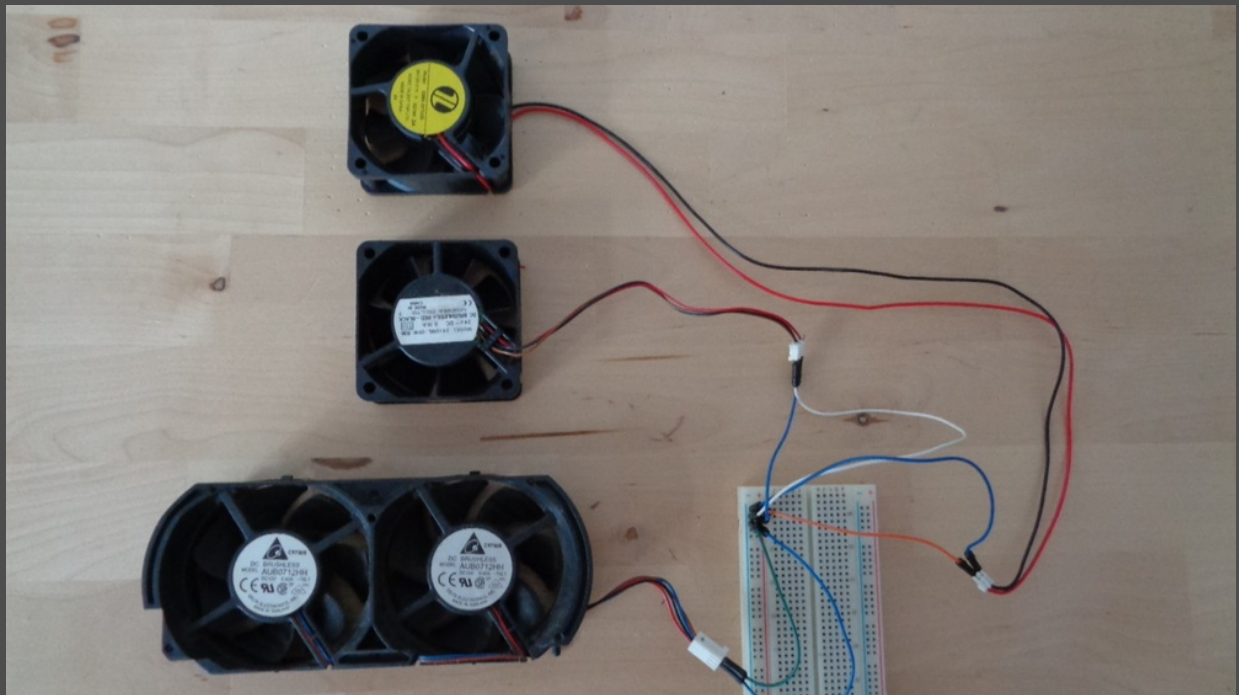

If you buy breadboard cables on the internet or in shops, make sure you have enough red and black cables. You need them very often and as a beginner you can quickly get mixed up with colorful cables. Since I've been working with electrical engineering for a long time, I've already done a lot of practice in there, so I can assign colored cables to a breadboard.
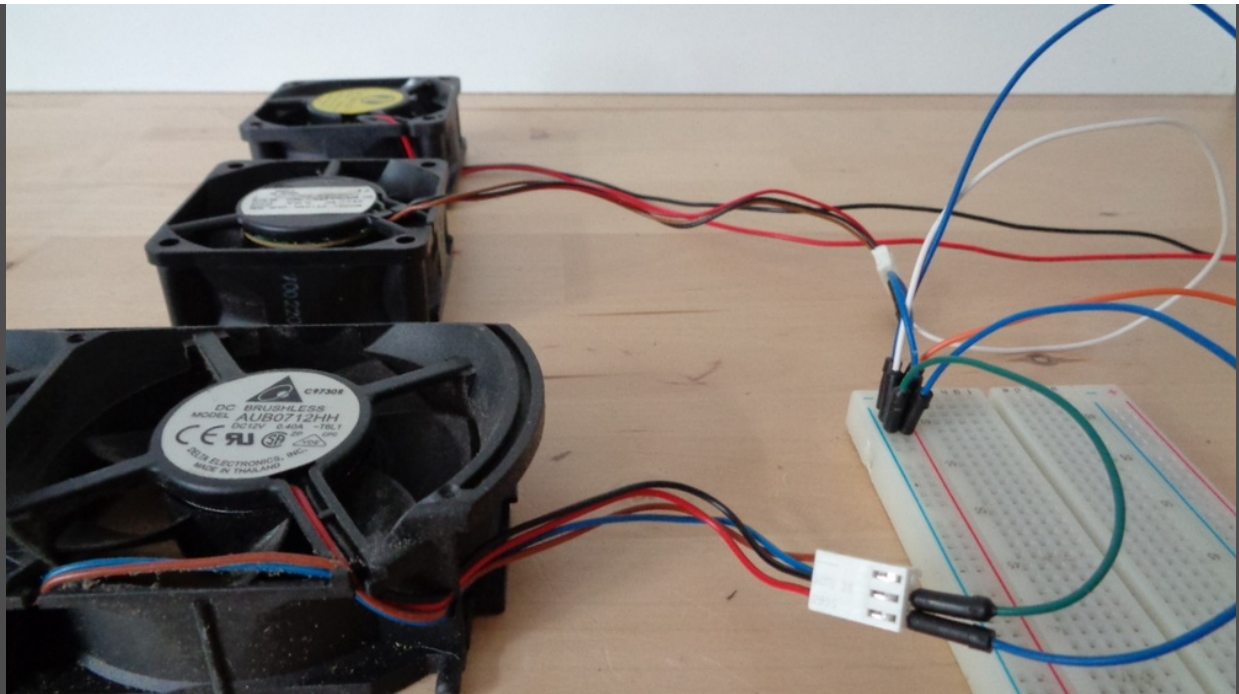
I describe now what you can see on the photo, otherwise you get confused. Since I don't always want to pull the mains plug out of the socket, I will install an on/off switch in the circuit. This is connected to the Luester terminal (red and yellow cable). The small white plug (red and black cable) is plugged into the breadboard with two beradboard cables. With this we will then lead power from the socket into the breadboard to let our fans run.
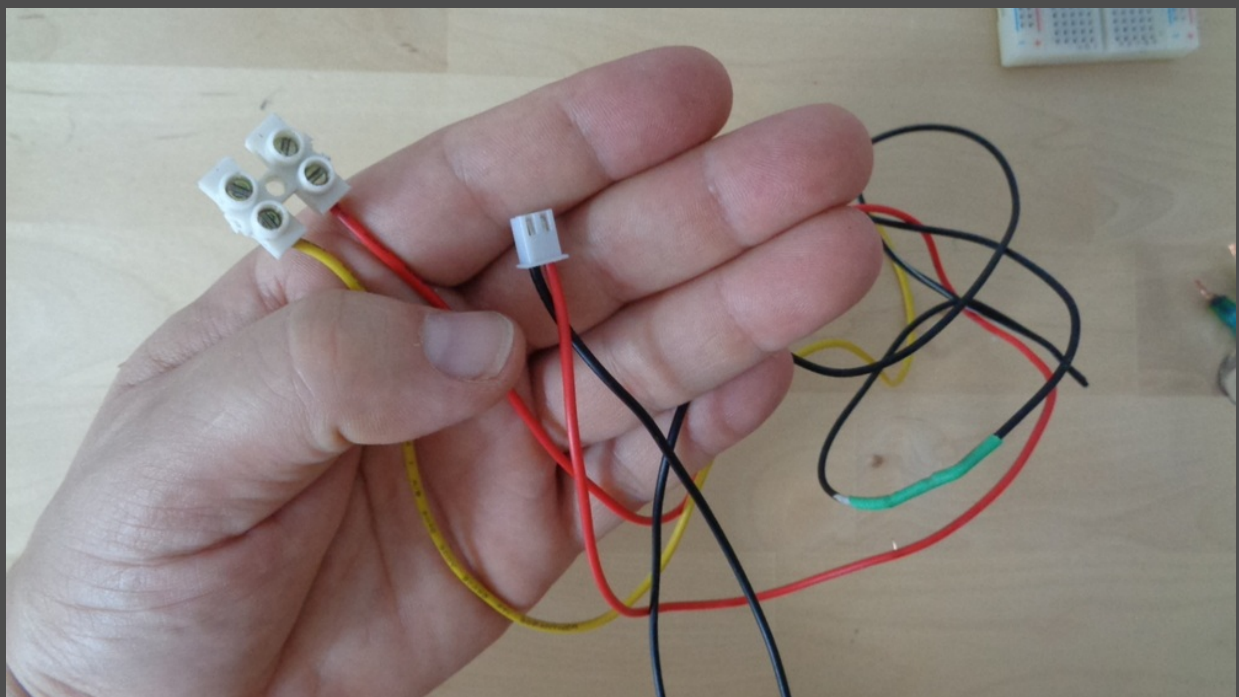
So that we can put the on/off switch into the Luester terminal, we must turn two small screws loosely. Then we can plug the cables into the Luester terminal. The ends of the cables must be bare metal, because otherwise no current can flow. With scissors you can carefully loosen and cut the sheath of the cable. Cut off only as much as you really need, because every bare metal part has to be isolated later to avoid electric shock. Bare cables within a functioning circuit mean danger. Unless you work with very low voltage.
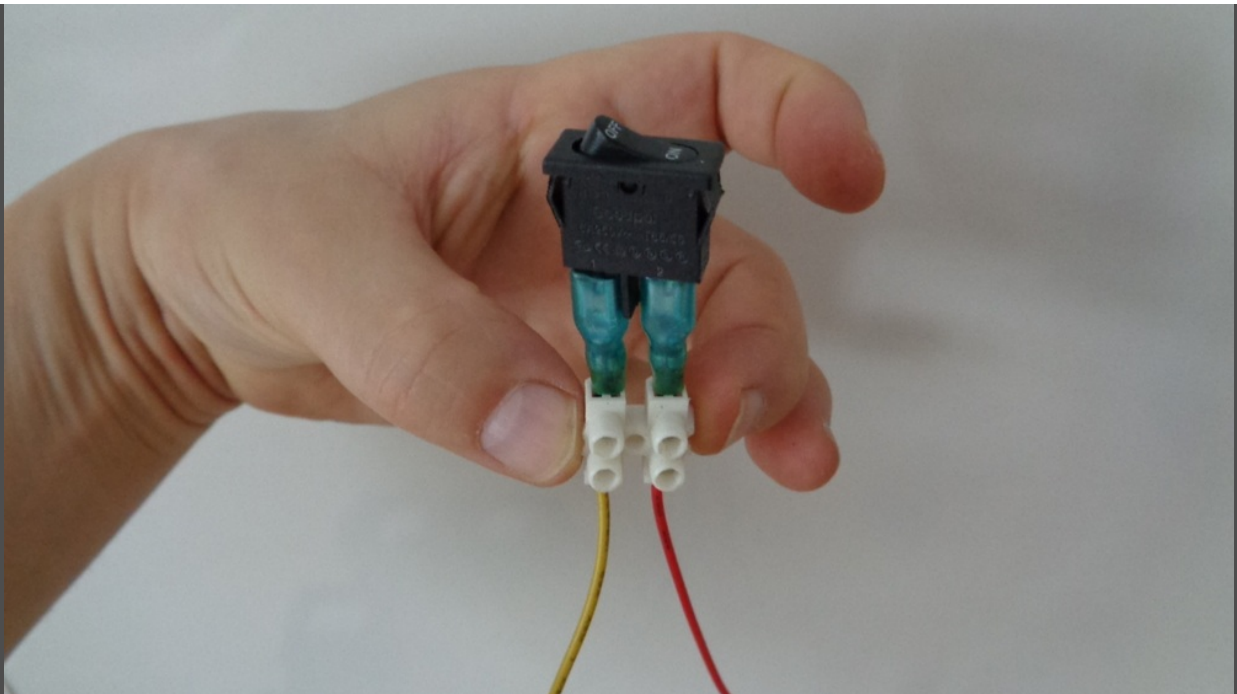
There are always ten small holes per block on a breadboard. Five for plus, five for minus. If you plug in more than eight cables, but you need a complete connection, you have to build a small cable bridge. This is done by inserting two cables (the yellow cables on the photo) into one block of ten (one cable each for plus and minus) and then into the next block of ten. If you don't do this, your circuit is not closed and you'll wonder why your project doesn't work.
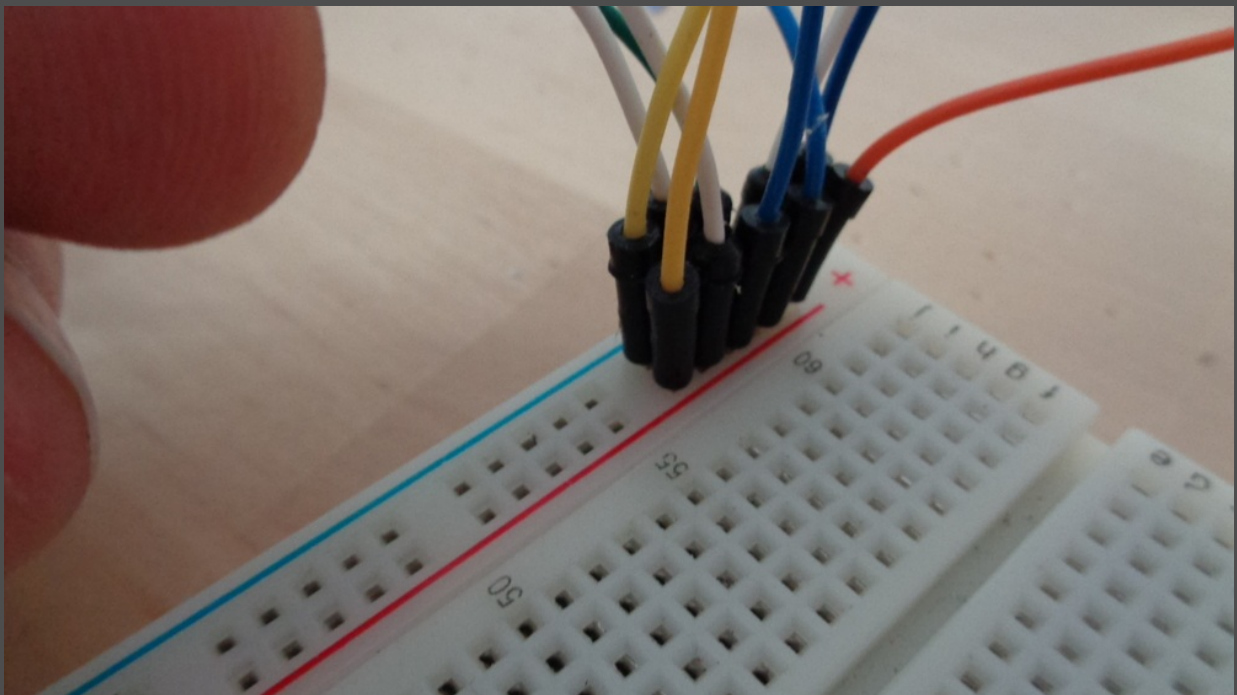
In between we test everything and look for mistakes so that we don't have to do it later. Here on the photo you can see that the one fan (at the bottom left) doesn't work. This was because the two cables were blue and brown and I didn't know which cable belonged in the right position. That happens all the time and that's not because you work unprofessionally. In theory, you plan everything exactly, but then you suddenly find mistakes in practice that you didn't see before. Of course you try to eliminate all mistakes in the planning phase, but sometimes you can't or just have to guess and try it out. That's how you work scientifically. First the theory and then the practice. This approach is called empirical research.

Here we see the complete prototype on the breadboard. It looks pretty complex at first, but it's not. Later we'll build all the material under our desk, but we'll have to clean and repaint it first. If you don't have to, you can skip this chapter and move on to the next one.


Clean and repaint the Table

When you start a big project, you should always think about including other unpopular tasks as well. Here on the photo we see my completely dirty and painted work table. It's a work table, no question but it shouldn't be so dirty either. I plumbed it, spilled coffee, stained paint and attached stickers. My two monitors have also been severely affected. Two years can pass very fast. because the monitors still work very well I will simply tape them off and repaint them (this is not described in this tutorial, otherwise it will be too long). Then I want to remove my parallel vice and my two drawers. Then I sand, grind and re-sand to repaint the table at the end.

This is my old laptop stand, which I will build new in the next weeks. It consists only of single metal rods, which are screwed together. A very simple but effective construction. With a red marker I drew a border, so that I know where the laptop is and I have to drill the holes. You can't see these lines later. A little note from my own experience. If you use markers you'd rather buy acrylic ones, because the normal Eddings leave streaks when you paint them with light colors. This is because of the solvents and you should do without them. Waterproof acrylic markers such as Molotow are best suited and can be easily ordered on the Internet.

Here I have drawn wrong and had to do this again. Please pay attention that you have to think mirror-inverted if you put the fans under the table. This happened to me later, but luckily I hadn't glued anything on yet and could just move it quickly.
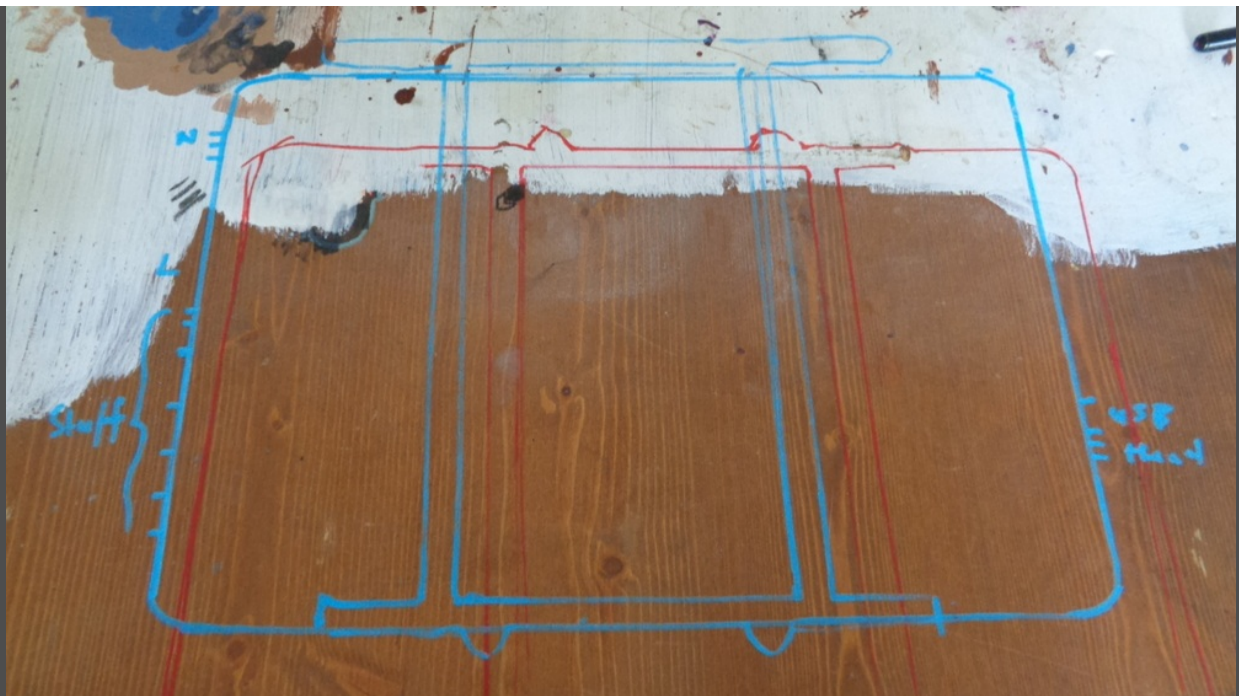
After unscrewing the parallel vice, I was able to plug the old holes. For this I always use old duebel or old wooden sticks and saw them with a wooden saw into the appropriate length. Before I put them into the holes, I lubricate them a little with wood glue, so that they hold. There one should take only very little glue, because otherwise it drips and spills.

If the duebel are a little too long, that is no problem, because the table is sanded once completely. But if the wood duebel is too short, you can use wood kit to lubricate the unevenness. Unfortunately I didn't have one at home and couldn't buy one that fast. Since the table is only a very rough prototype anyway, it will be replaced later by a much better wooden plate. So you should always go to your projects, because it's like Minecraft. The first night you build a house out of earth. The second day you go felling trees to get wood and build or extend your house. That's how it goes on and on. You work your way forward a little bit to finish something really epic. This is how almost all my projects work.

What you can't see on this photo is how long I sanded this table. Five hours because I don't have a belt grinder. It's a really miserable job and I'm glad that I don't live in the Middle Ages anymore, where everything had to be done by hand. Since I already bought myself an electric circular saw this month, I have to wait until next month. My shoulders and arms felt as if I had carried an elephant through the area, and I was able to see how much I needed this tool.

Because I will drill holes in the middle of the table I can't use the drawers under the table anymore. I have to rub this off and put it back in my work cupboard until I can use it again. You don't have to throw it away immediately and you can stow it somewhere. I mention this again and again in my tutorials, so that the environment is not polluted so much. Please don't throw everything into the garbage immediately.

Since the wooden plate was an old plate, a small piece had been sawn out at one corner. You can easily refill a damaged area. I got a suitable piece of wood from my box.

So that I can saw the wood better, I clamped it to the worktop. I use metal screw clamps to tighten the wood. The plastic ones work too, but they break too fast. The best clamps are made of wood and are also used by carpenters, but they cost a lot. So that I don't make a hole in the wood with the screw clamp, I put a small plate in between.

Here I hold the sawn piece of wood to the tabletop to see which size fits exactly. You can measure something like this exactly, but I didn't want to invest too much work into this old tabletop, because it should look only roughly good.


There are hundreds of ways to attach wood. My idea was to fix the piece with wood glue and duebles. I drilled holes in both parts with a drilling machine. In contrast to me, you have to hold the wood firmly while drilling, because I had to hold the drilling machine with my right hand and the camera with my left hand in order to take the photo. Please don't do that like you can see on the photo, otherwise you'll hurt yourself. Wear your safety glasses because splinters in the eye are a painful injury.

Here you can have a closer look at the holes in detail. You can also drill from only one side, so you don't have to plug holes on the other side. I already said above that I only wanted to do this roughly, so I didn't bother at this point. Don't invest your important life time too much in details, if that's not necessary. Save it if you really want to build a clean final product. This is one of the differences between professionals and beginners, but everyone learns it with time.

So that the two duebel hold better, I lubricate them a little with wood glue. You can simply dip them into the glue and wait a few seconds until most of it has dripped off again and then tap them in lightly with a hammer. If a duebel is too long, simply bring it back to the right length with the saw.
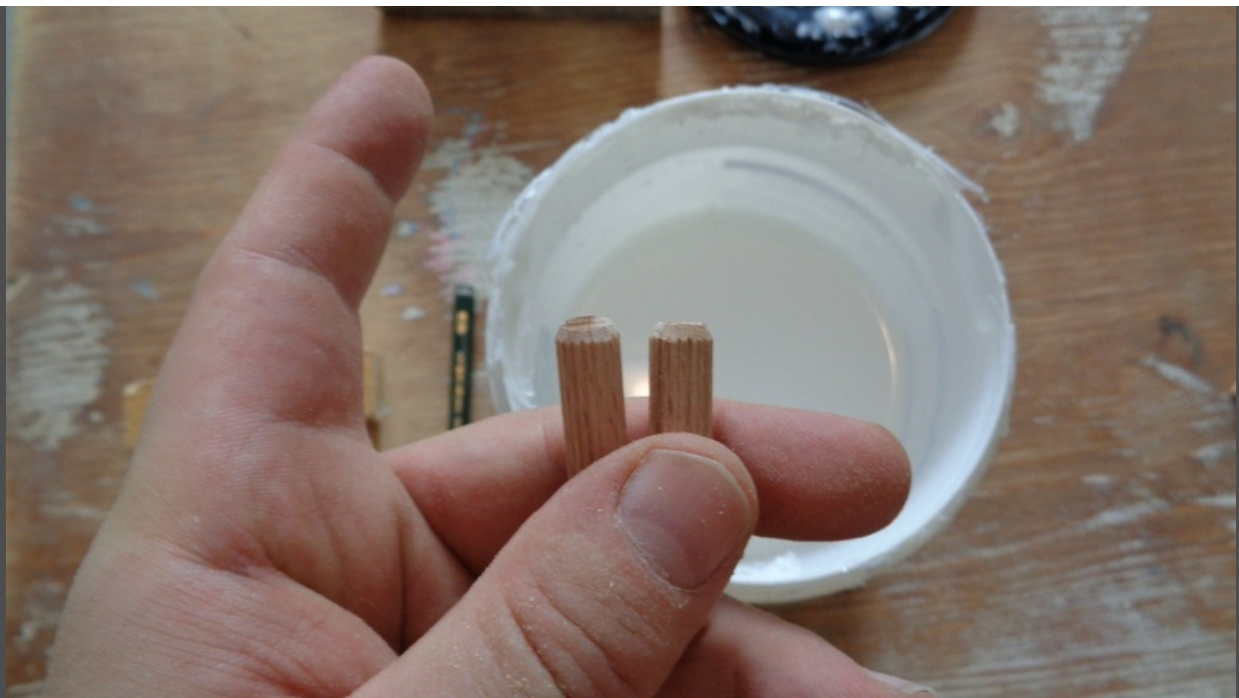
After the two duebel were fixed, I smeared the other piece of wood with glue. Here you can already see that I did not drill quite as straight as I had planned. But I don't let such a small mistake stress me and continue to work on the big plan.

If this place would be important I would rip everything out and make everything new. Nevertheless I let everything dry before I saw the edges right, so that it doesn't slip any more, because it looks much too bad now. Since I have to work in the next steps on the underside of the table, I turn it over.

On the underside of the table is a wooden strip that gets in the way of our holes. The man (or machine) has fixed this strip with glue and disposable screws. So there is nothing else left for me to saw them into pieces and break them off with a pipe wrench.

For such a task I always have a small hacksaw which is also used in primary school. This is the fastest saw to work with, because a big saw is too unwieldy in most cases. At this point please do not saw into screws or nails, because this will break your saw.


A large pipe wrench is best used to break the bar. You can also use a hammer, but that's usually too loud and splinters fly in all directions (even in the direction of your eyes). You can also use a big screwdriver and push it under the ledge and bend it upwards. No matter how it is done you should use the *leverage* to save a lot of work.

After breaking off the bar, I turned the table top back to the other side. That can be saved and you don't get confused with the arrangement of the fans. As I already described above, I noticed this in time before gluing the fans and saved me even more work.

So that I am sure what is going where I have the fans once again arranged on the table before I have drilled the holes. You should always do that so you don't have to make any mistakes. It also helps to change your perspective, so that you're really sure you're building it right.
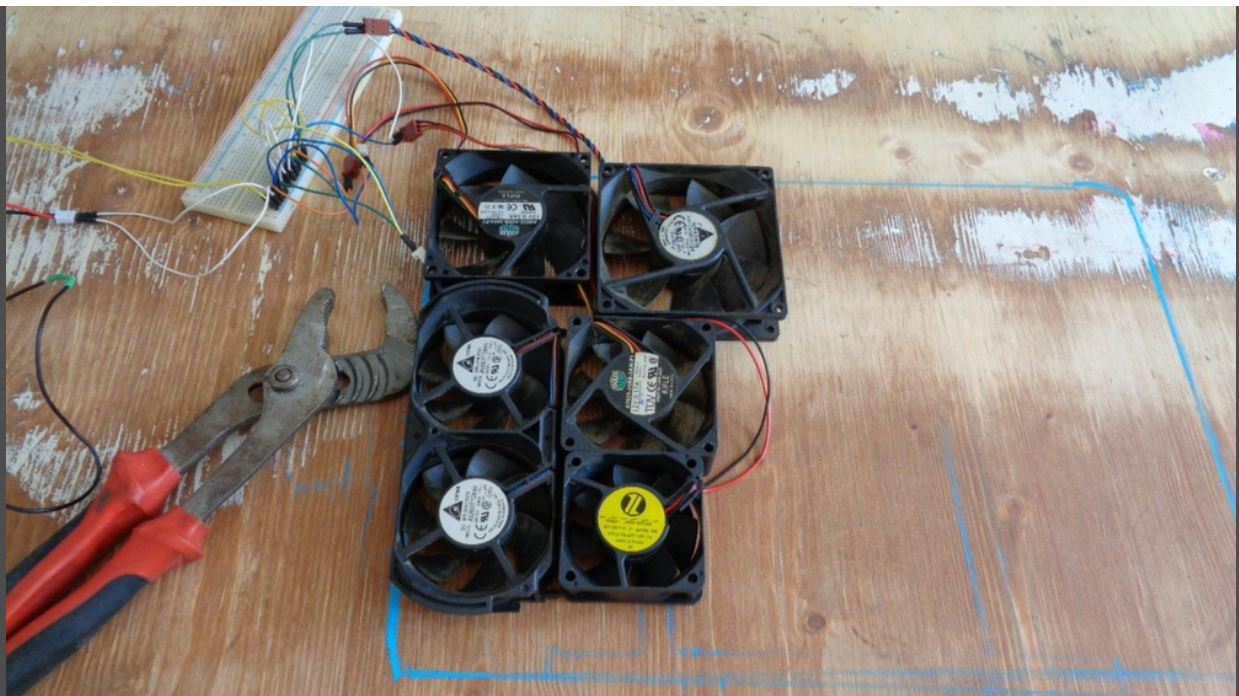
So that I know exactly where I have to drill the holes, I mark myself with a wooden ruler. The ruler is about one cm wide. But you can also make it wider, because at the end of this tutorial I will say something about the holes, which I only thought of later. I marked the lines with a graphite pencil.

This is what the complete checkerboard pattern looks like. A hole is drilled at each point where the horizontal and vertical lines cross.

After 408 holes the table looks like in the photo. Drilling is more exhausting than I thought and my shoulders hurt a lot.

Since the table was made of pine wood, it splintered while drilling and I had to free every single hole from small spans again. That I have made with a matching rod of metal, which I had then always pressed into one of the hole.

After turning the table (once again) over, I could also remove the spars on the other side. This is a really exhausting job and if I want to build a second version of this table, I have to find out beforehand which wood species are splintering and which are not. Spruce wood should not be used. This doesn't seem to be due to the drill, because I used it in other projects and it didn't happen there.

The coarse splinters can best be removed by hand or with pliers. After that you should at least sand the holes again with sandpaper and a sanding block so that even small splinters are removed.

There was a special reason why we didn't saw the new piece of wood immediately. After we have finished all the other tasks, the wood glue has dried so firmly that nothing will fall off when we work on it. So we can saw without worrying about something breaking off.

It looks ok from above....

...from the side rather not.

When we have completed all the tasks at the table, we come to the last step in this chapter. The varnishing. Again, I saved time by not sanding the primer again. Without a sanding machine you get crazy. If you want to varnish something, you should wear the suitable clothes. This includes old clothes, because even if you don't see it when spraying, the wind spreads small color particles that stick to the clothes. You should also wear old shoes. Do not spray in the apartment because there are poisonous fumes that should not be inhaled. Therefore it is best to wear a special painting mask, which you can buy in the hardware shop or on the internet. A dust mask is only of limited use. Please do not save money on your health.

When you spray you start at the top left and then go up right with the spray can. You do this in a straight line. Don't go too fast, but don't go too slow. You need a little practice and experience to get the hang of it. Always from left to right. Do this until you reach the lower end of the plate. Then start from the top right and spray vertical lines. Always from top to bottom. Until you've reached the left side. Normally two layers should be enough, but it can happen that the wood absorbs a lot of the primer and you need a third or fourth layer.

Normally you should sand the primer clean before applying the black paint. Since I wanted to finish it in one day, I saved this step. With the black spray can we apply the paint exactly as we learned it above.


The primer and paint must dry for at least two hours before we can continue working. In the meantime you can take a break and eat something. Since the varnish is only completely dry after 24 hours we put old cloths over the wooden frames. With this we protect the fresh varnish and make sure that it doesn't flake off again immediately. Now we arrange the fans the way we want to put them on the table later.
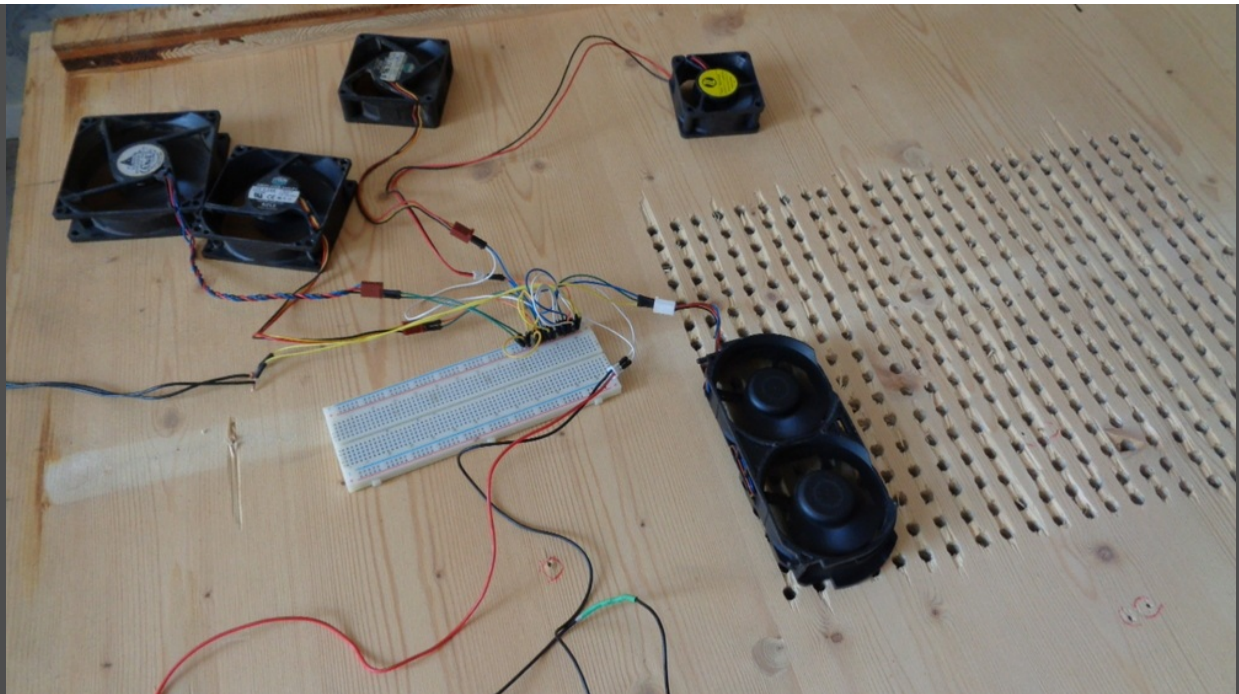
If you want to implement an idea, you should not only work quickly but also economically. At this point there are a lot of people who would have used a real circuit board for the wiring. You can do that, but it costs you far too much time and money. A prototype has to be built fast. The goal of a prototype is to build something functional, not something nice. You have to resist the temptation of overengineering, otherwise you will fail miserably. Design comes later, because technology comes first. That's why I use copper tape here. You can order it cheaply on the internet and stick it on meter by meter. We need a (-) and a (+) strip.


Since we need two strips, we simply cut something out with the carpet knife in the middle. Also a reason to use copper tape. You can change something quickly. With a circuit board this is not so fast.
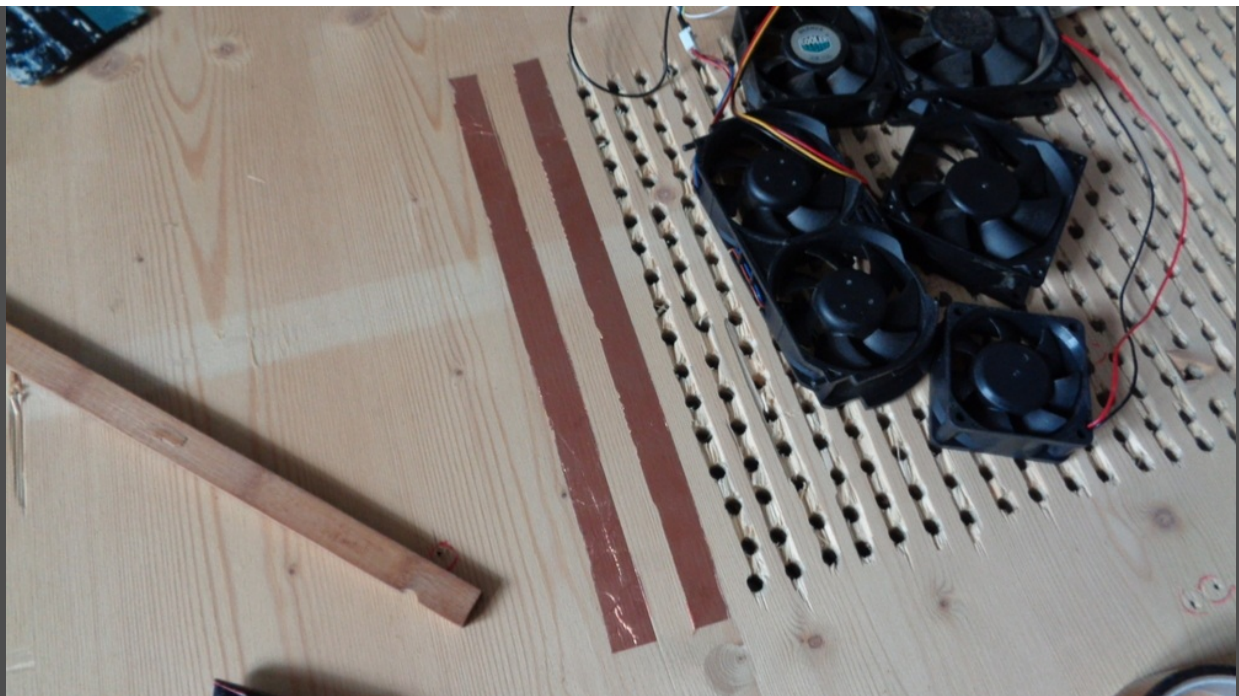
So that I don't get mixed up later with all the different cables I marked myself with electrician tape where plus and minus have to be connected. Electrician tape is a certain adhesive tape which does not burn so fast or burns by heat. This is important because we will be working with the soldering iron right away and it gets very hot. You can also mark it with two coloured pencils if you don't want to use adhesive tape. I notice right now when making the documentation that using pens is also cheaper and more environmentally friendly. I have to remember that for the future.
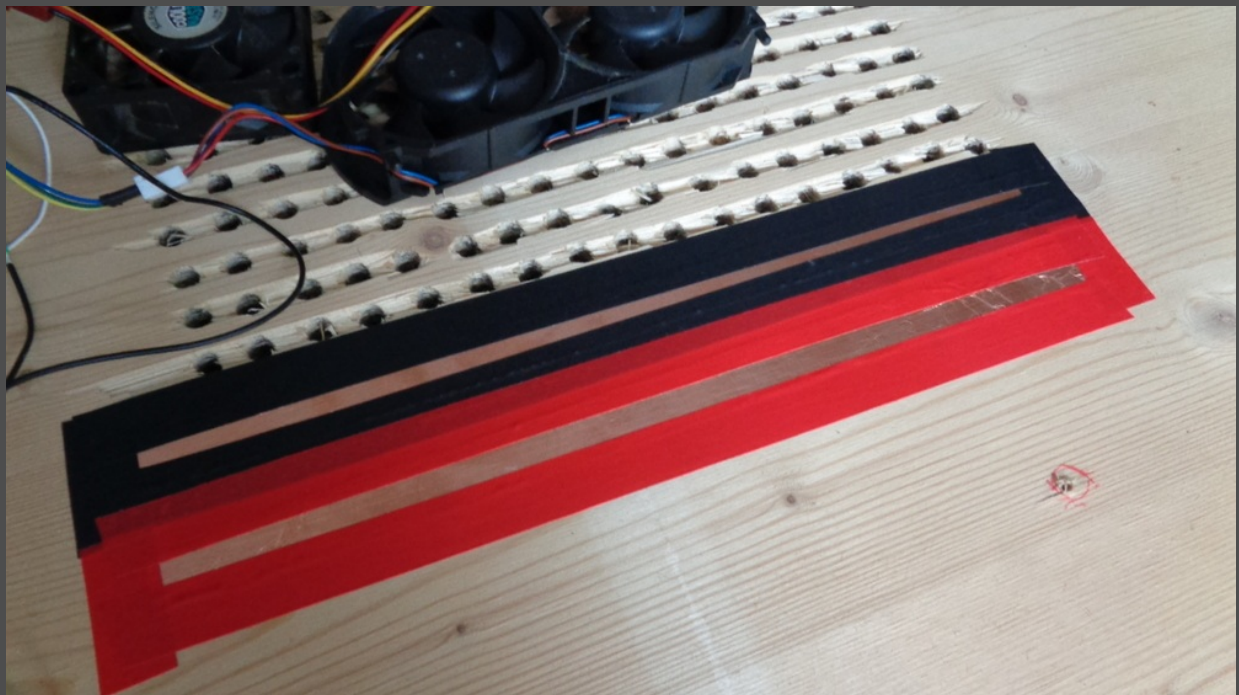

We don't immediately start to solder cables to the two stripes, because we first test everything to see if it works as we planned it to. I had to learn that the hard way, because I almost ruined a complete project. In the end I had "only" the double work and that is really demotivating. To fix the cables I used masking tape. It's expensive, but it keeps well on the copper tape and you can take it off later.
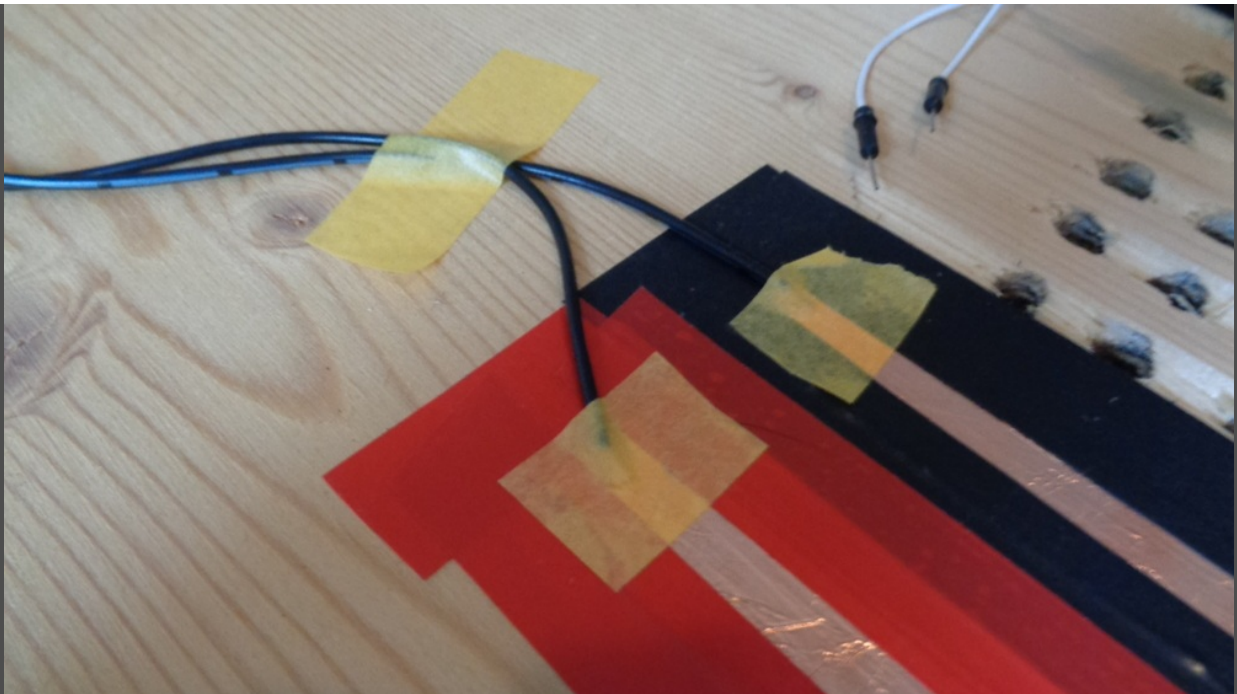
Even if it looks a little different now, it is the same structure as on the breadboard. We just transfer it.
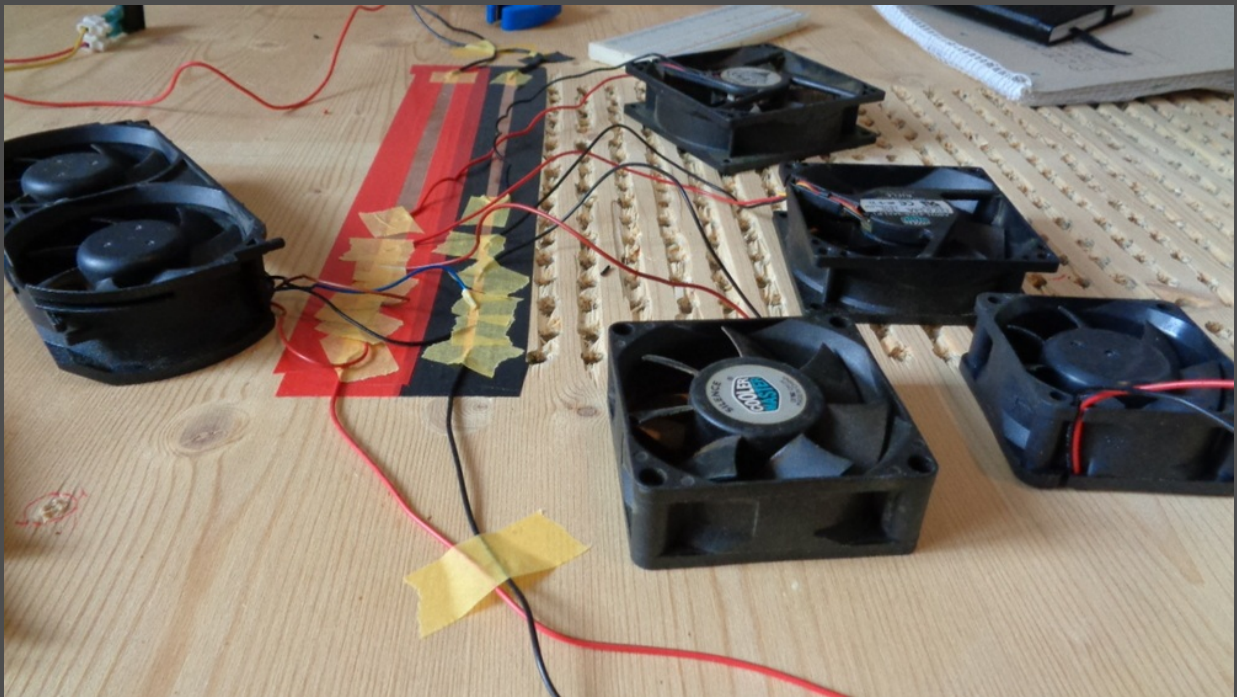

Here again the on/off switch. Here you can see exactly how the two cables go to our copper tape strip and how the fans can get power. In my opinion switches are one of the most important inventions of electrical engineering and very powerful components if you know how to work with them. They are often underestimated.
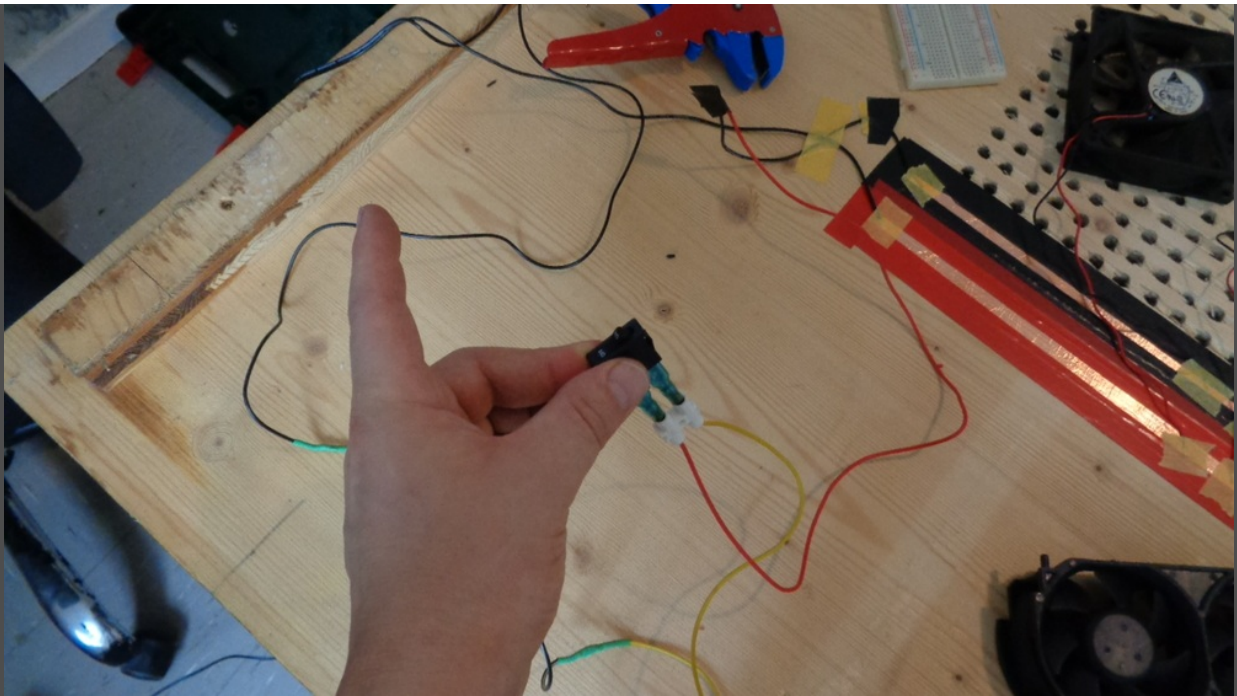
In order to connect the switch with the remaining wiring, it must be soldered. We cut off the plastic at the end of the two cables and twist them slightly with our fingers. On the photo you can see a twisted cable end on the left and an untwisted cable end on the right.
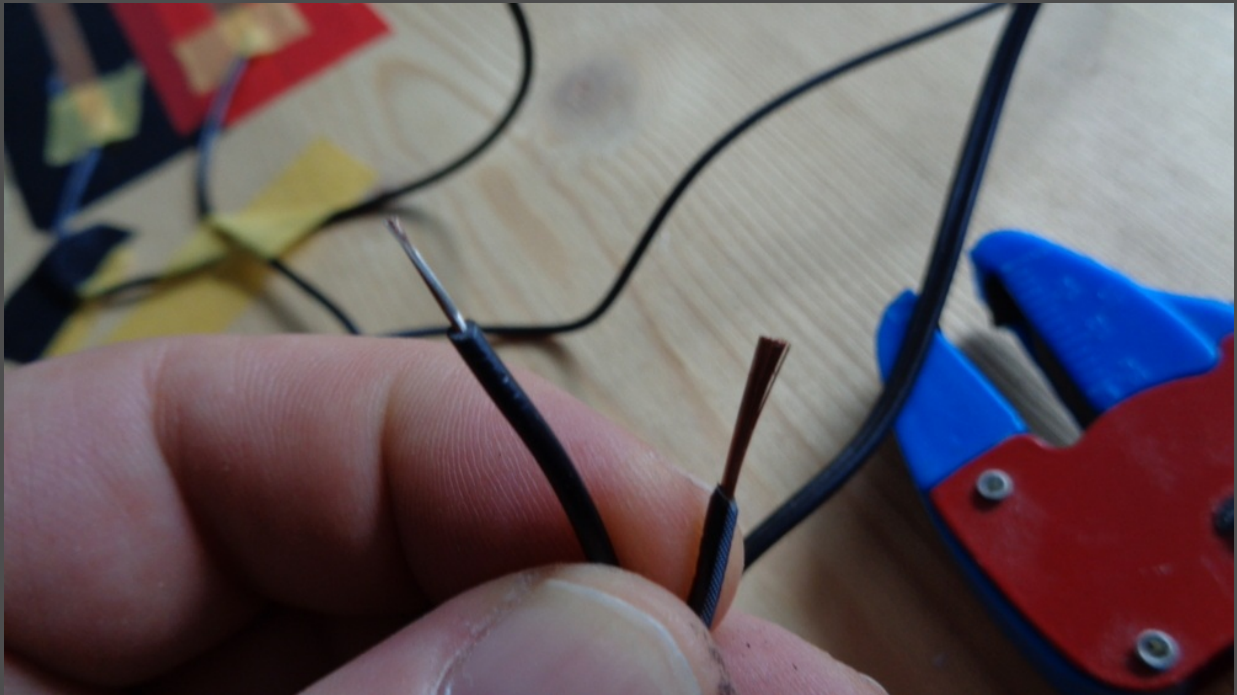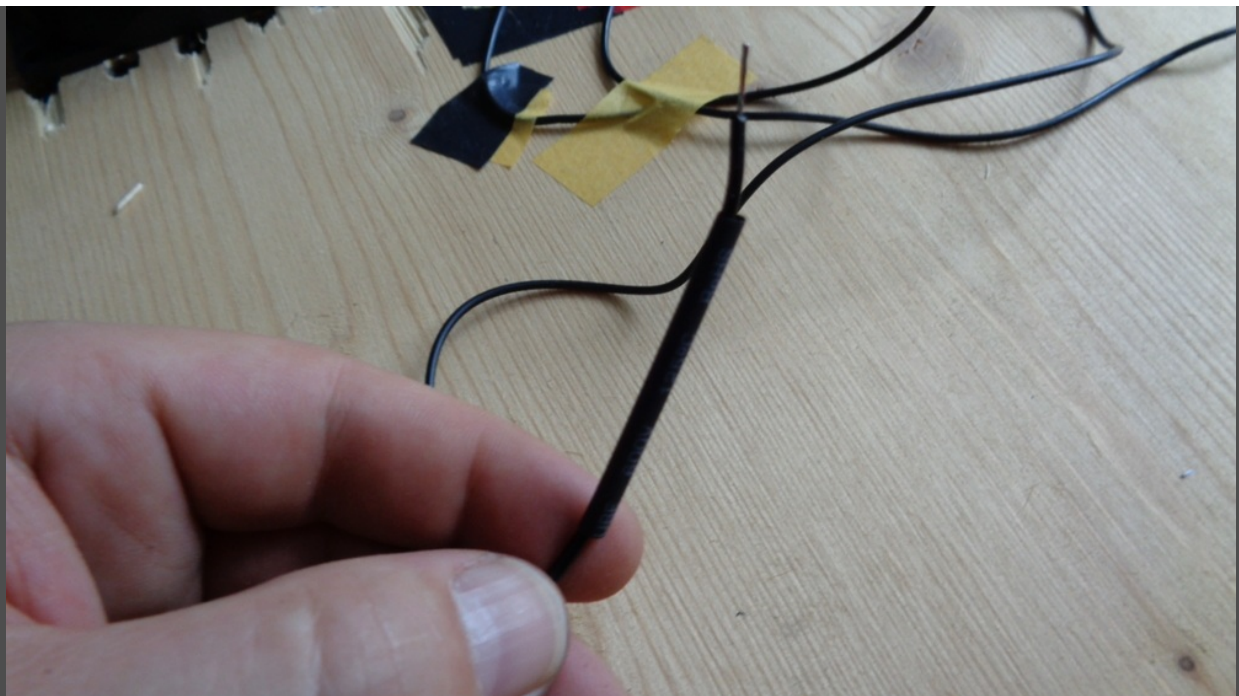

Here you can see once again a twisted end in detail.
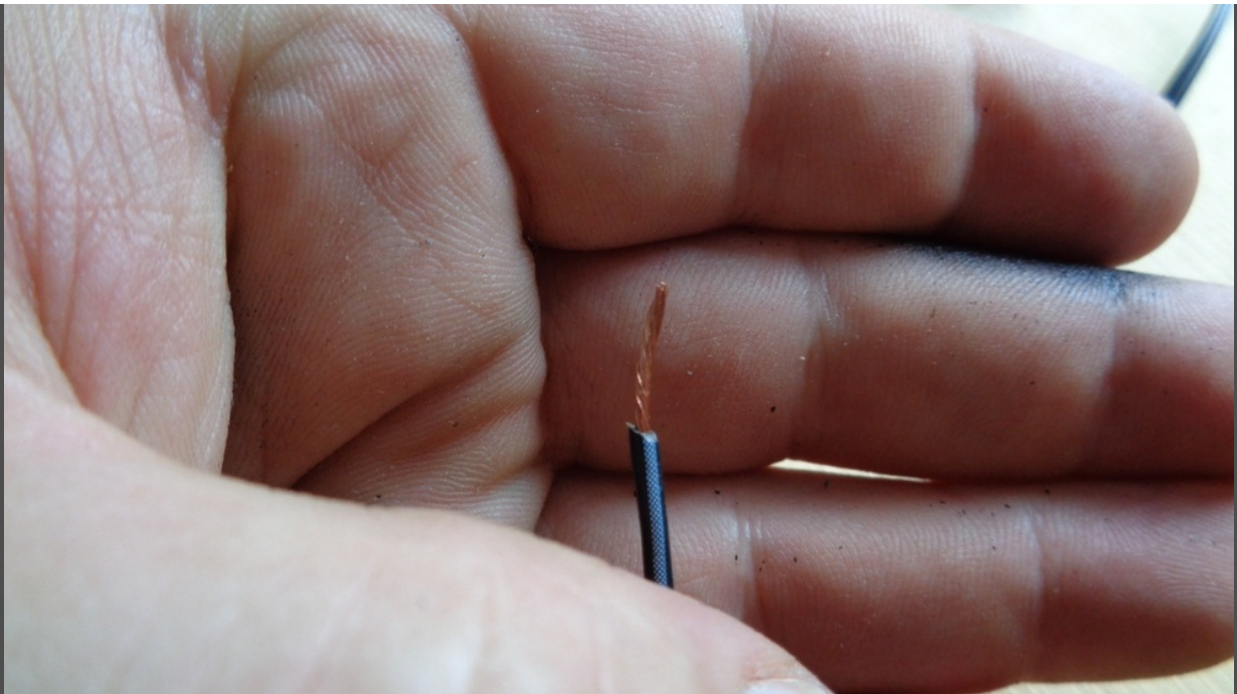
So that the soldering point is not barely wired later, we will cover it with a shrink tube. We cut off a suitable piece for it.


Then we pull the hose onto the cables and solder them. When the soldering point is no longer hot, the shrink tube is placed over it and is shrunk with a lighter until the point is tightly closed.

Now we can start soldering properly, because we have to connect all cables to the two strips. We always pull off a piece of masking tape and solder the place with the cable. Then the next piece and so on, until we have soldered everything. It should be as clean as possible and cables should not be loosened without destroying the copper tape.


Since I had to extend a cable, but had only yellow cable left, I glued a small red adhesive strip to it, so that I know whether it is plus or minus. These are also things you only learn after a few years, because you always forgot before.
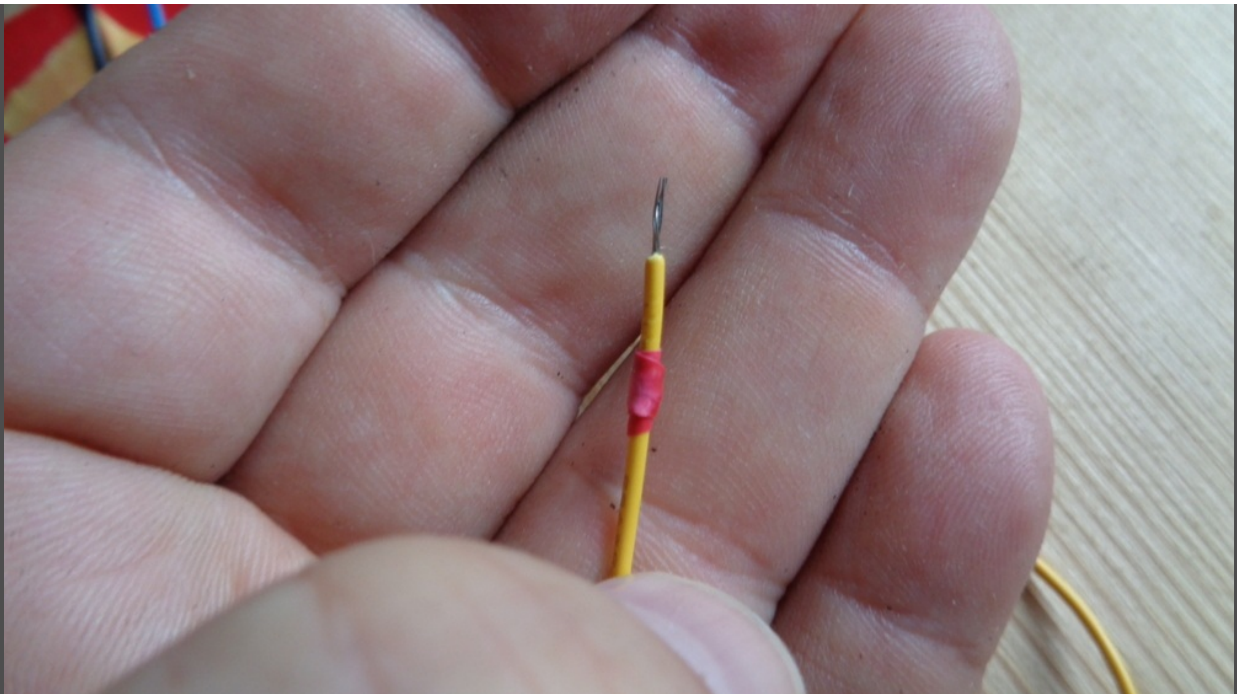
Actually I refrain from using the hot glue gun, because the hot glue is difficult to remove from materials. With this project I made an exception once, because after a few days or weeks everything will be dismantled anyway. You often see this in videos with Chinese or Indian teenagers who really put great ideas into practice, but then use hot glue. This takes away the possibility to rebuild your project later. You should always think of something like this before you start, for example if you bought fans that were expensive and you might want to reuse them sometime in another project. For my Danish Coffin Bed, for example, I didn't use any glue at all.
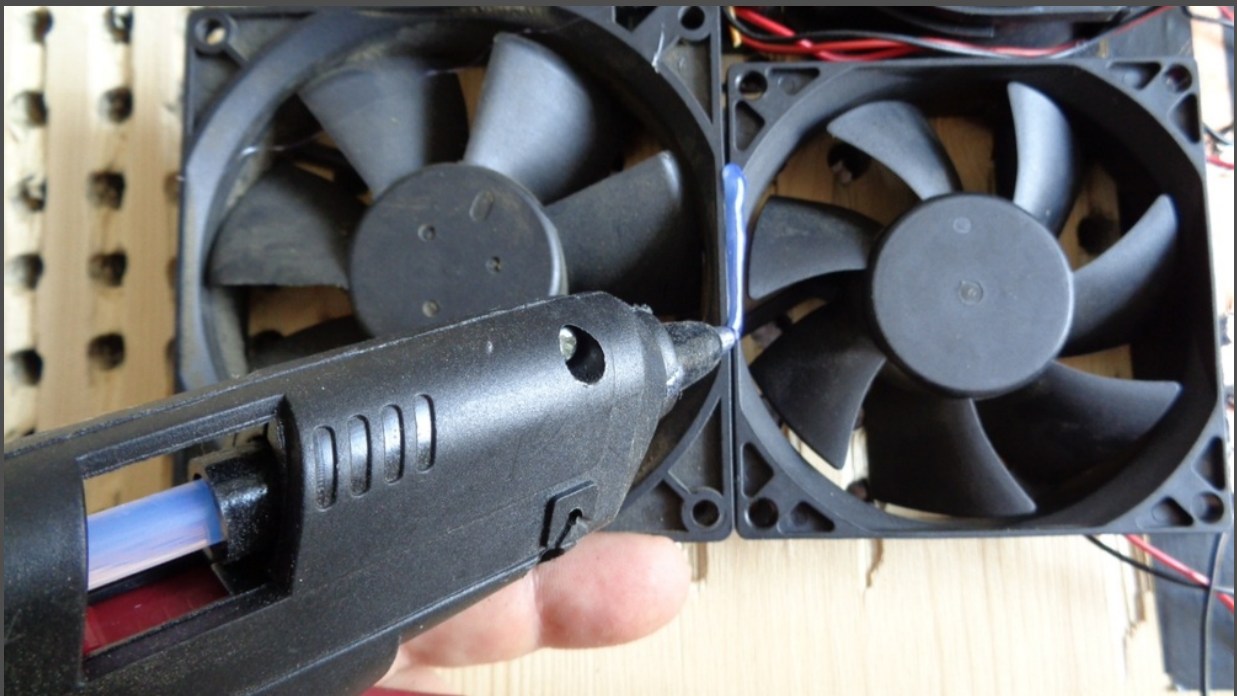
To get to the on/off switch faster, I glued it to the side. So I don't have to move much when sitting at my desk.
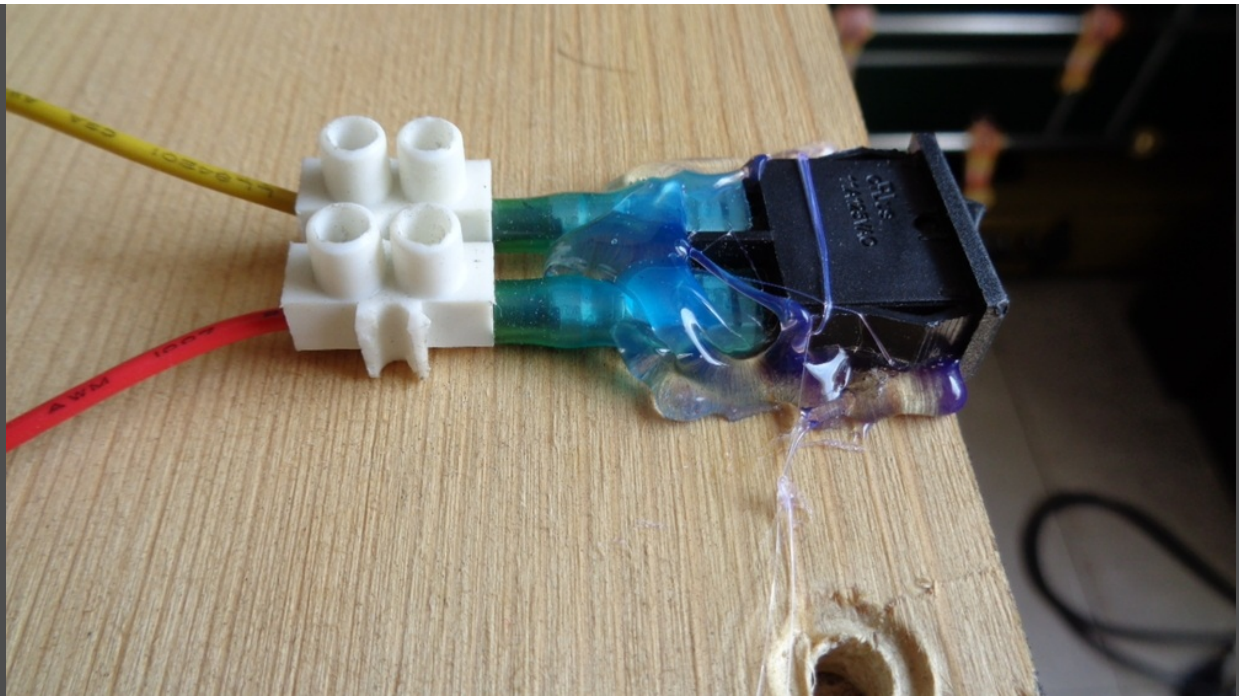
In the last step, all loose cables are glued with adhesive tape so that they don't get in the way. We are now finished with the actual work. The table can be turned around again and everything can be set up. When I press the switch all fans go on and blow air to the bottom of my laptop.
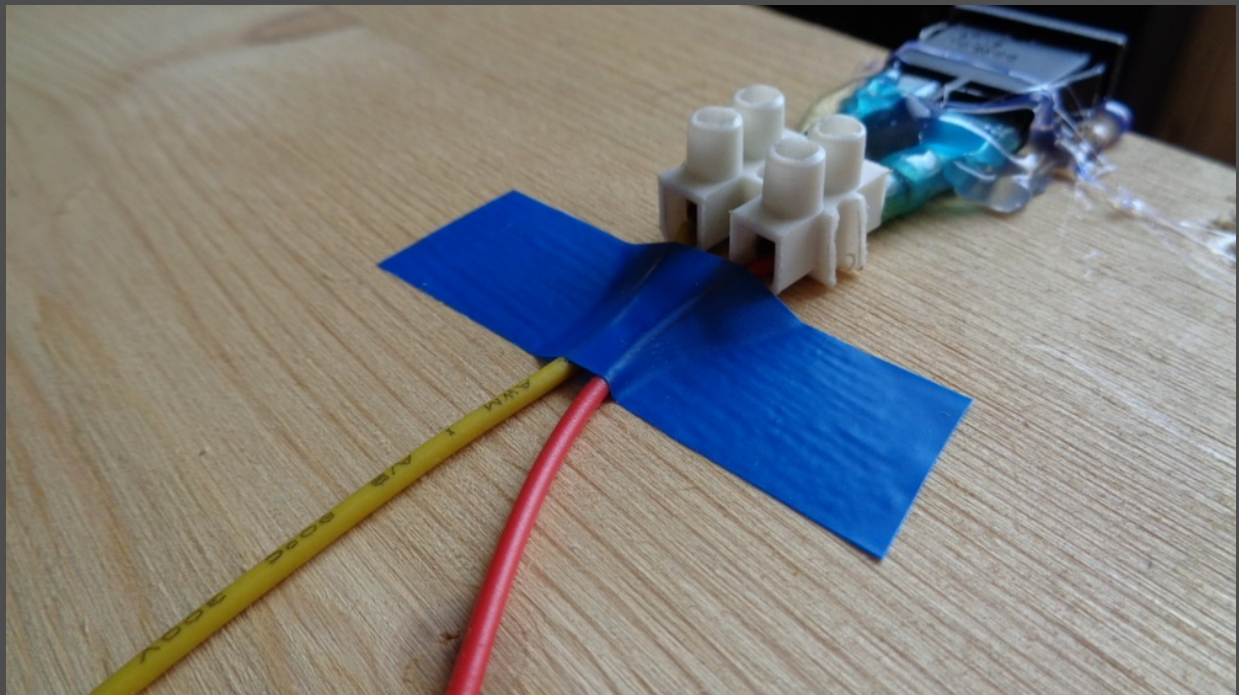
Conclusion

In this project I learned a lot, e.g. because right and left are always confused with each other. This only happens in my head, but it's exhausting when it happens at work. Also the holes in the table are much too small and there is not enough air. I could have sawed bigger holes in the table, but I didn't want to risk too much at once. Small holes can be filled faster. I've already made the drawing for the second version, because as we already learned in the intro text, I can cool down my laptop by -12C with this very simple prototype. I'm pretty sure there's much more to it. But I need 12 new fans and another tabletop. But if really more fans mean more cold air, I'll find out later. Until then I can finally play Rising World without roasting my CPU, because that was the real reason for this project.